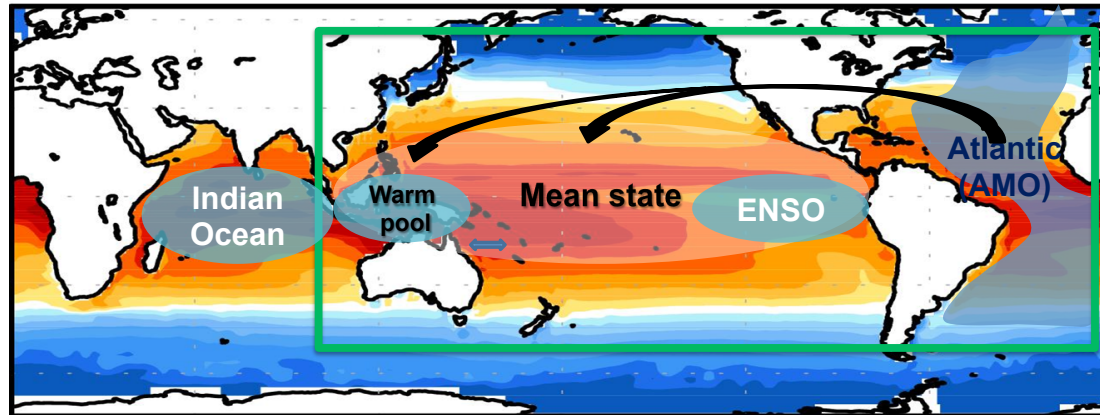


AMO Influence on
the Pacific Interannual Variability

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Seoul National University

Fred Kucharski
ICTP



- 1) Mean state changes over the tropical Pacific
- 2) ENSO amplitude modulation

Background: Previous studies

✓ **Atlantic SST warming influence on the tropical Pacific climate**

[Hong et al. 2013](#); Ham et al. 2013; Ding et al. 2012; Frauen et al. 2012; Kucharski et al. 2011; Rodriguez-Fonseca et al. 2009; Jansen et al. 2009

✓ **The linkage between Atlantic SST and ENSO variability using observational data and coupled GCMs**

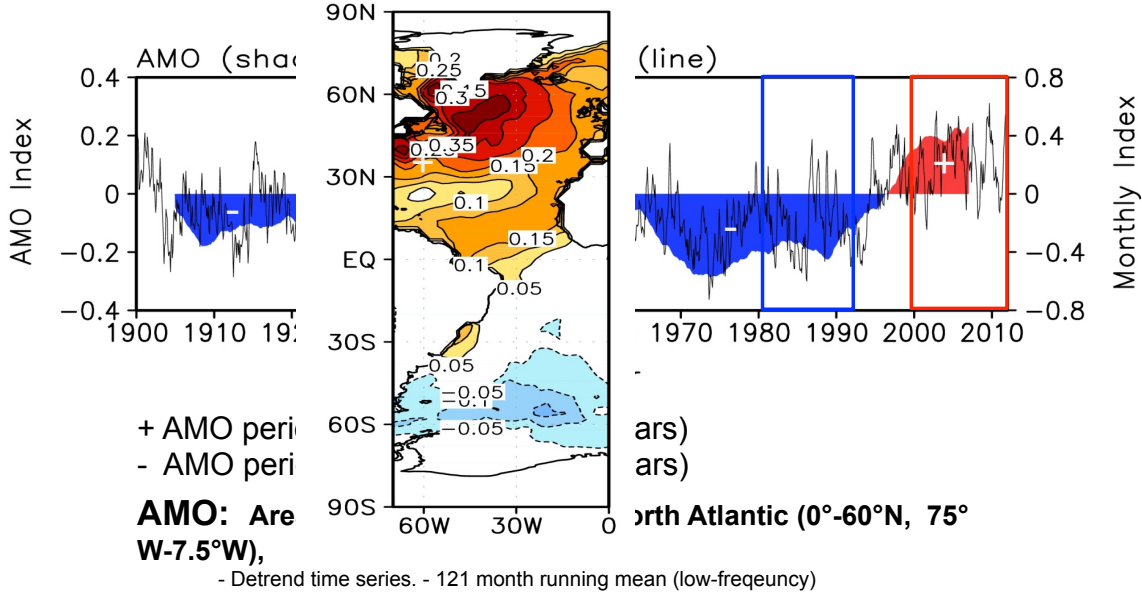
Svendsen et al. 2013; Keenlyside et al. 2013; Kayano and Capistrano 2013; Lopez-parages and Rodriguez-Fonseca 2012; Rodriguez-Fonseca et al. 2009; Dong and Sutton 2007; Timmermann et al. 2007; Dong et al. 2006

The mechanism underlying the relation between Atlantic SST and ENSO variability

[Kang et al. \(2014, J Climate\)](#), [Hong et al. \(2013\)](#)

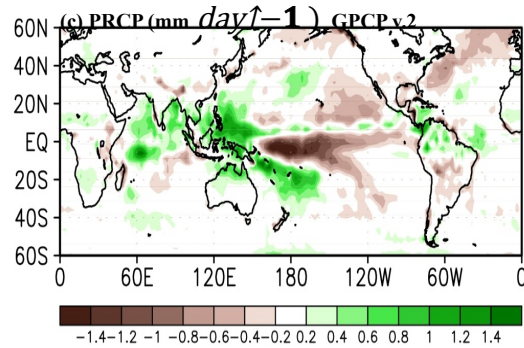
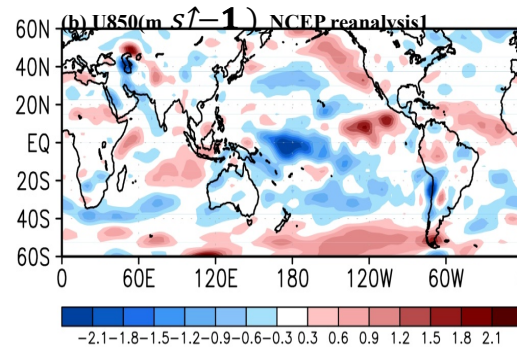
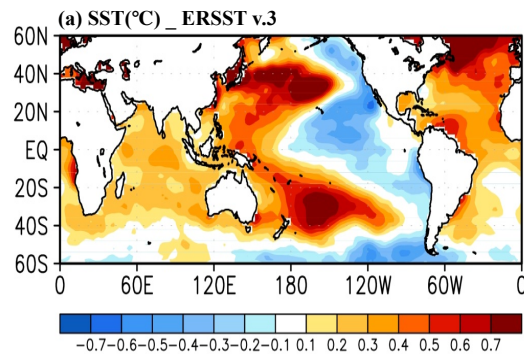
Atlantic Multidecadal Oscillation (AMO)

EOF1 (SSTA)



Mean state changes from observation

➤ Difference between + AMO period and - AMO period

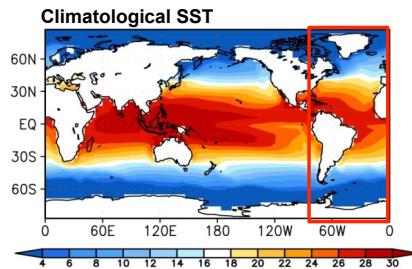


Q) What part of these changes in the tropical Pacific can be explained by the Atlantic?

CGCM Experiments with Atlantic SST forcing

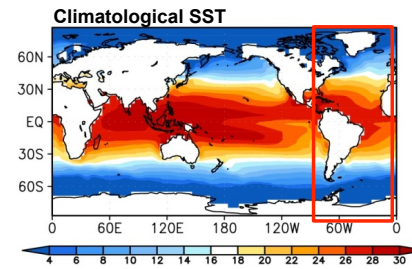
Control run (CNT)

- ✓ Atlantic Ocean
- SST nudging with climatological SST

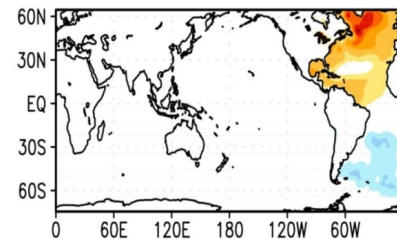


AMO run (AMO)

- ✓ Atlantic Ocean
- SST nudging with climatological SST
+ **observed SSTA**

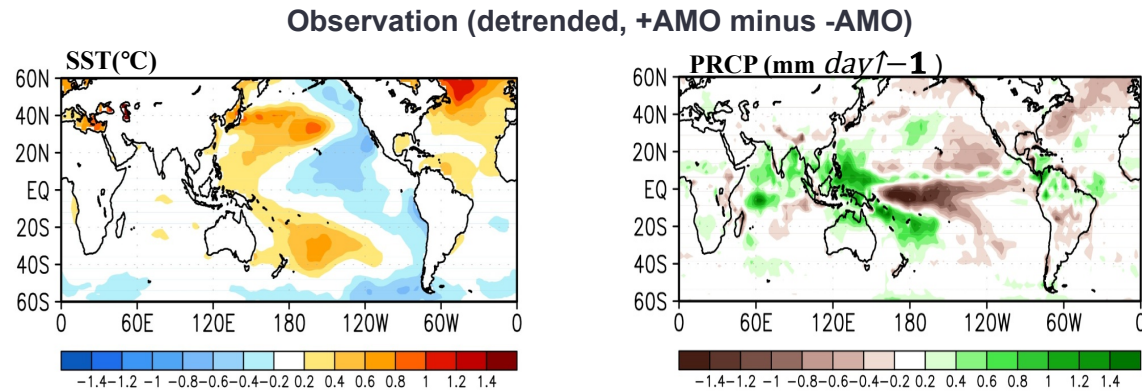
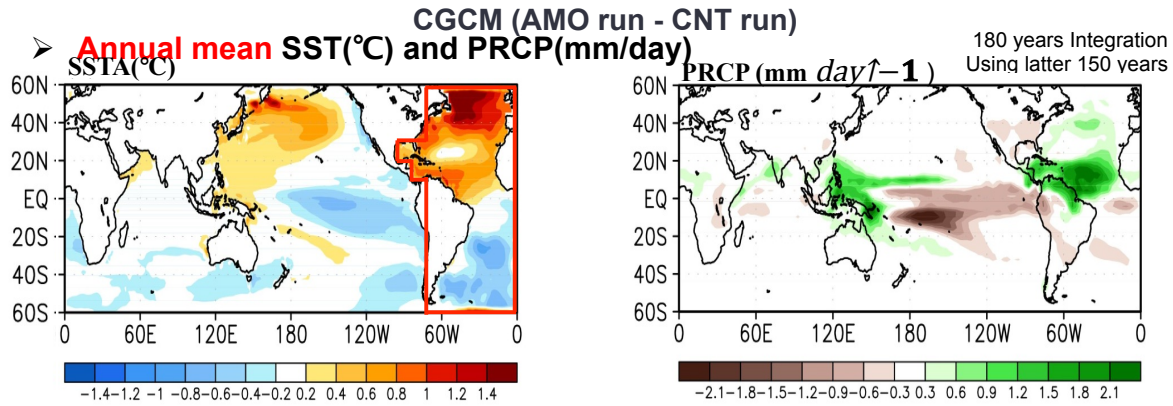


+

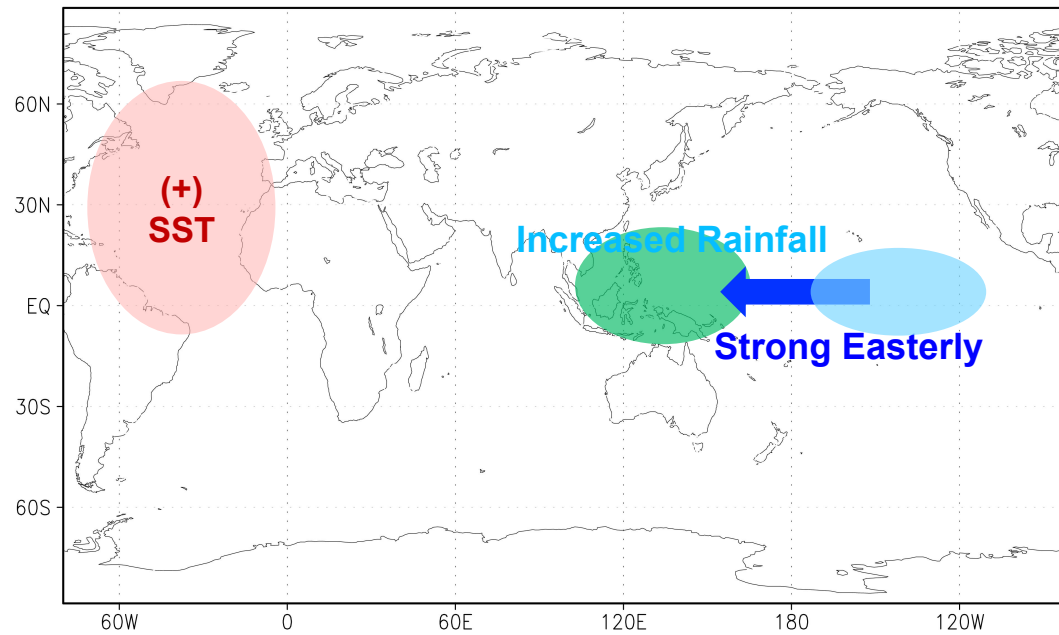


SST anomaly is not varying with time

Difference of annual mean SST and precipitation



Influence of Atlantic SST anomaly on the Pacific



AGCM Experiments

1. Aqua planet Experiment

- Control R : Zonal-mean SST
- Anomaly R : Zonal-mean SST + Atlantic SSTA

2. Warm Pool run

- Control R : Zonal-mean SST + Warm Pool
- Anomaly R : Zonal-mean SST + Warm Pool + Atlantic SSTA

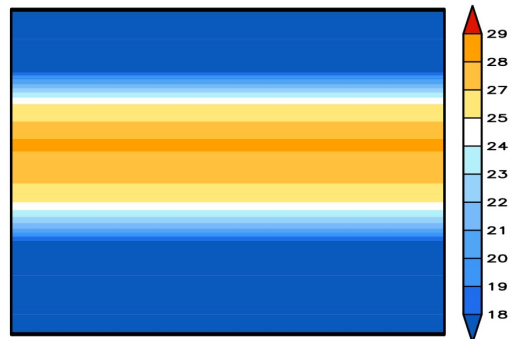
Aqua planet experiment

- Results from AQUA PLANET
[Ideal.ATL Forcing] - [No Forc.]



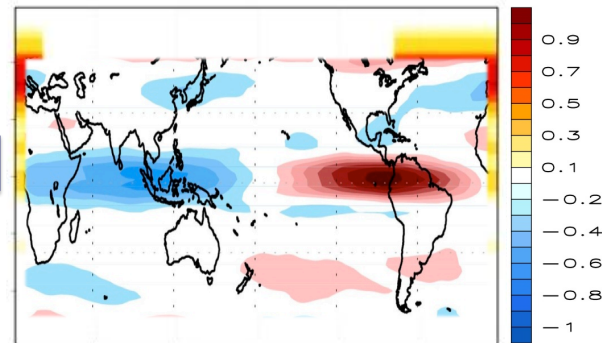
AQUA
Planet

The world that wholly c
overed with the ocean.



+

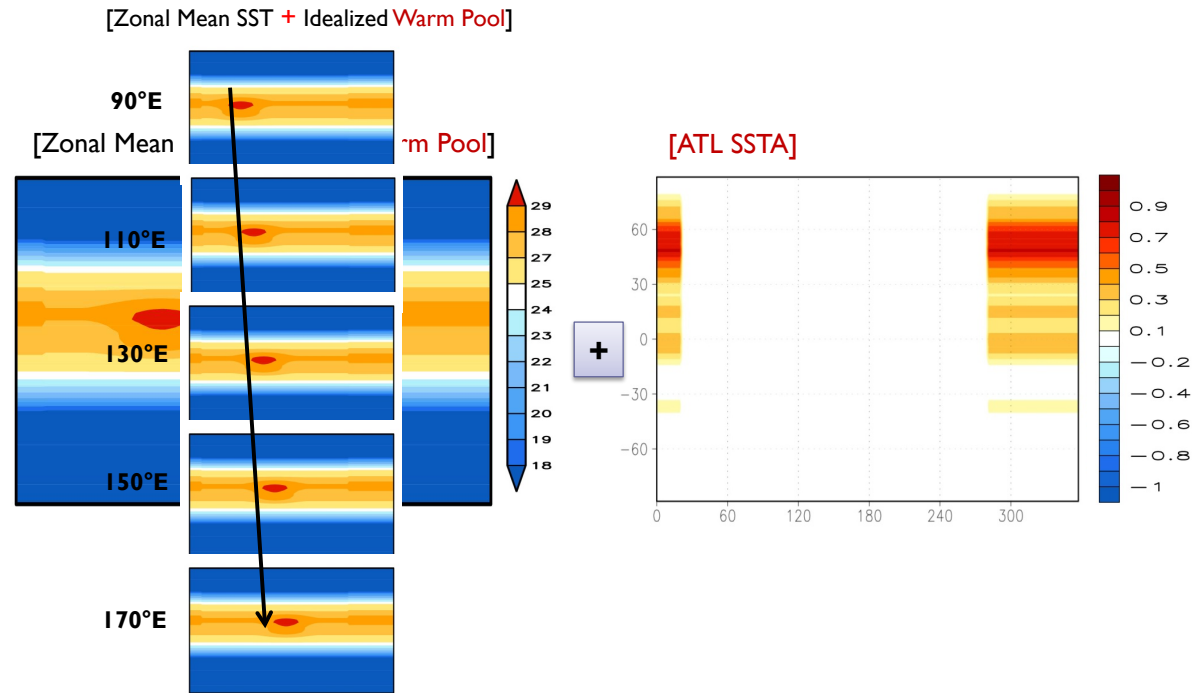
Anomalous U850 (m/s)



Warm Pool run

➤ Considering an idealized **Warm Pool**

Model : SNU AGCM (ver. spectral)
11 yrs Perpetual run (Use 2~11 yr)



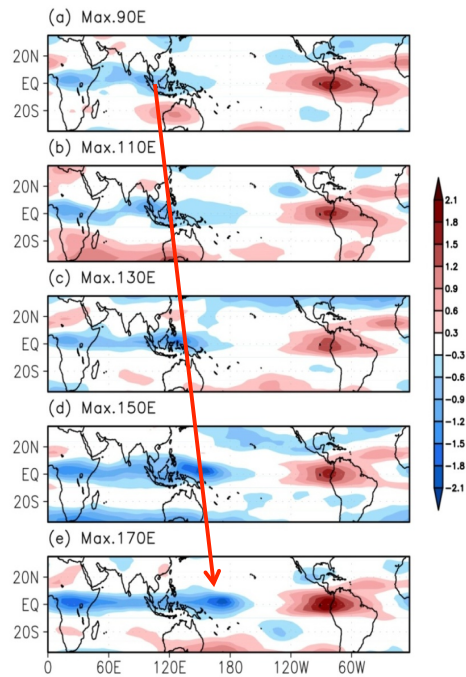
Effects of Warm Pool in the Equatorial Pacific

- Considering an idealized Warm Pool
 - Longitudinal location of Maximum SST

(Hong et al. 2013)

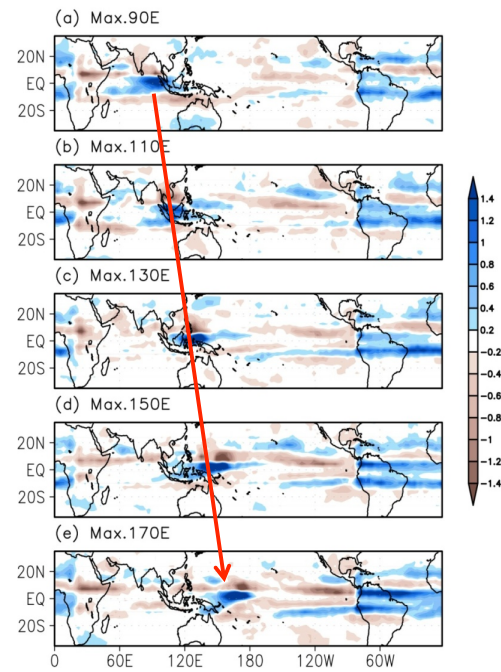
[Zonal Mean SST + Idealized Warm Pool]

(2) Anomalous U850 (m/s)

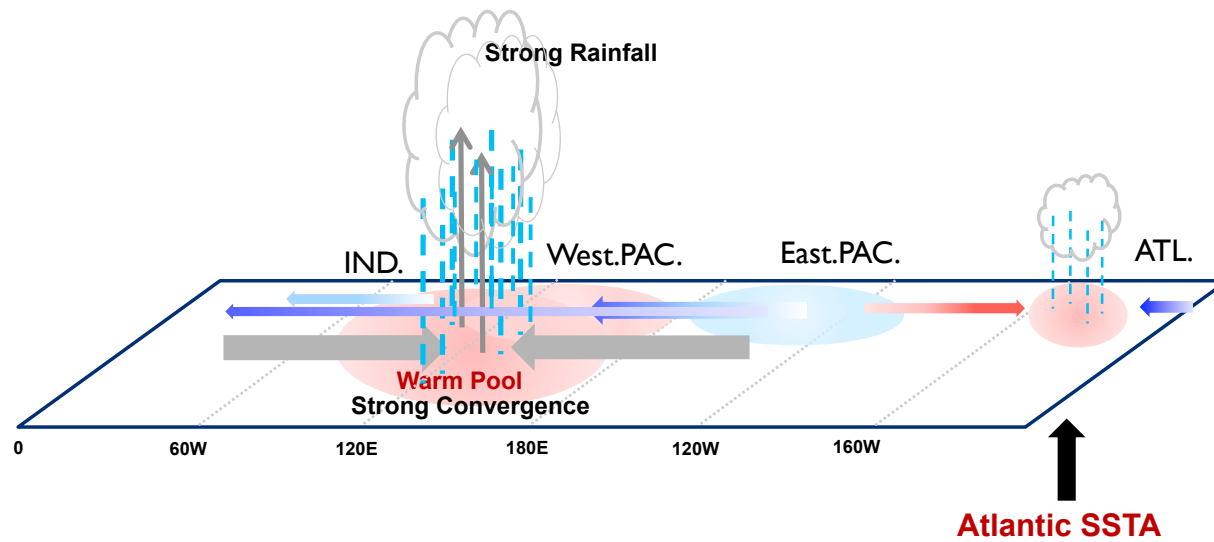


[Ideal. ATL Forcing] – [No Forc.]

(1) Anomalous Precipitation (mm/day)



Role of Warm Pool



Stronger easterly anomaly in western-central Pacific

Increases Precipitation anomaly in western Pacific.

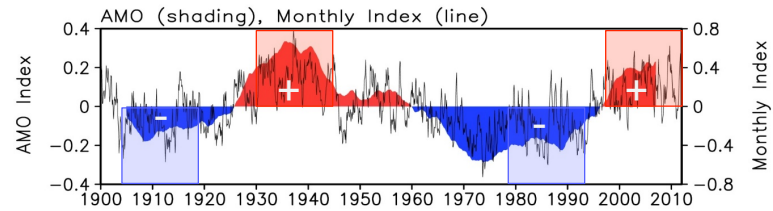
Summary 1

- ✓ **Impacts of Atlantic SST anomaly on the tropical Pacific mean state**
 - SST cooling in the central and eastern Pacific
 - Easterly wind anomalies in the central Pacific
 - Precipitation increase in the Western Pacific

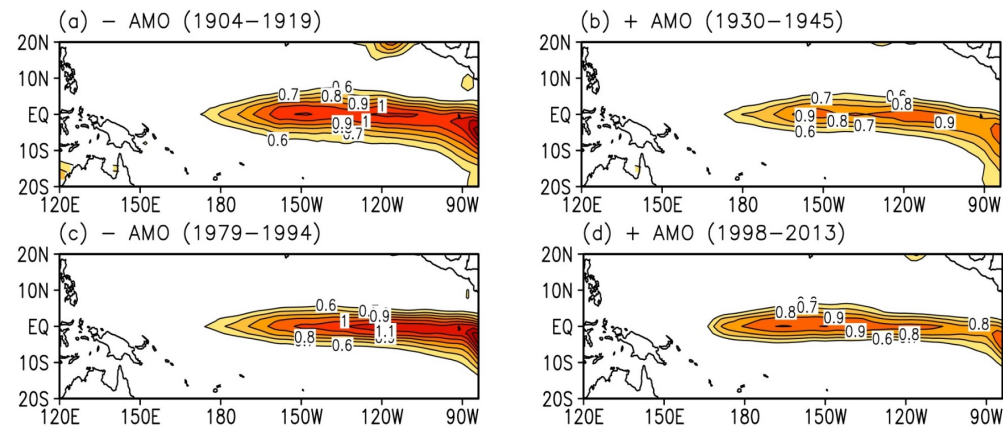
- ✓ **Warm pool in the western Pacific plays an important role in the Pacific response to the Atlantic SST anomaly**

AMO influence on ENSO

SST variability - Observation

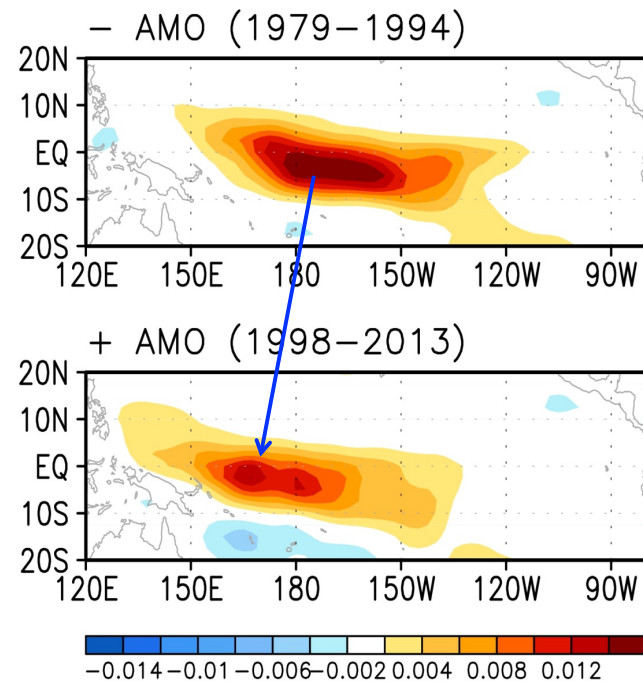


- Standard deviation of detrended monthly SST anomalies

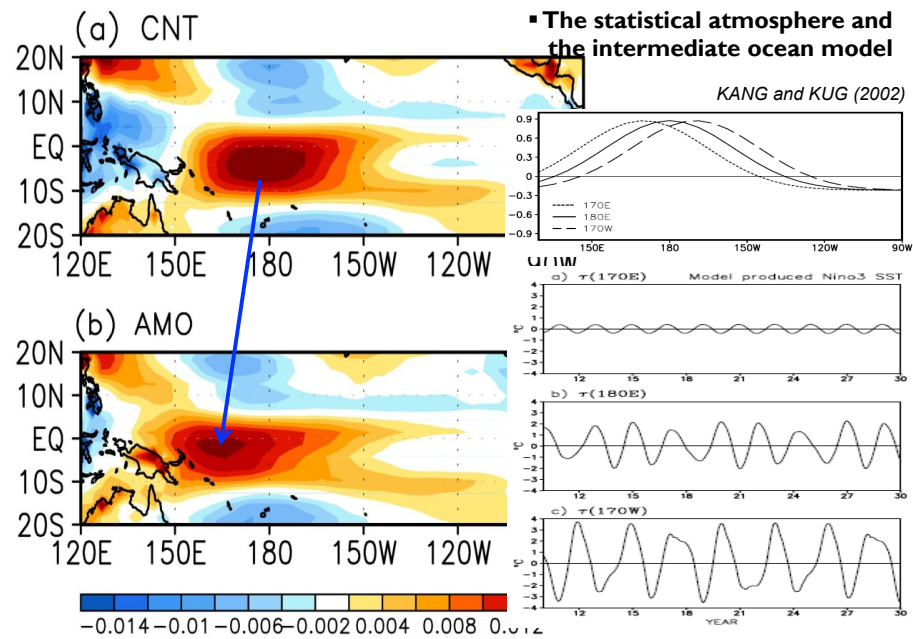


+AMO → -ENSO SST Anomalies
-AMO → +ENSO SST Anomalies

Anomalous ENSO zonal wind stress - OBS



Anomalous zonal wind stress - CGCM



A westward shift of zonal wind stress related to ENSO plays a key role in the reduction of ENSO variability.

Intermediate coupled CZ model

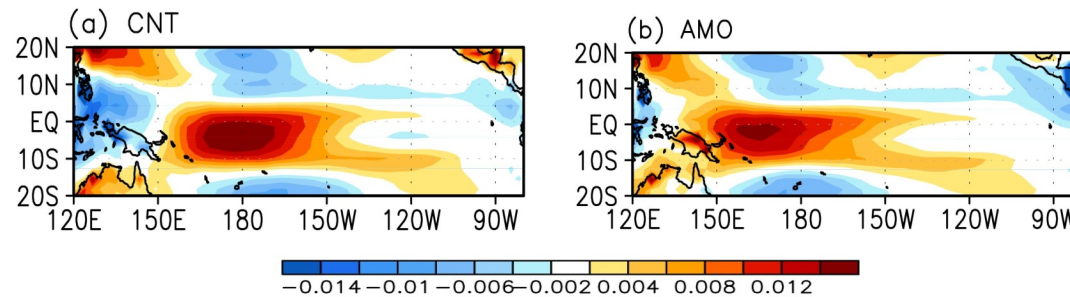
Impacts of zonal location of the zonal wind stress anomalies on ENSO amplitude.

KANG and KUG (2002)

$$\tau(x,y,t) = \alpha F(x,y) T(t)$$

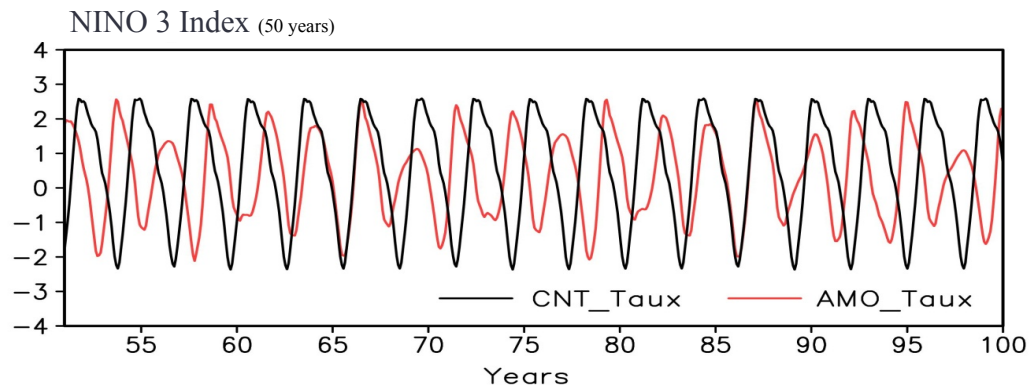


- Regressed wind stress (N/m^2) anomaly onto NINO 3 index from CGCM runs.



CZ Intermediate coupled model

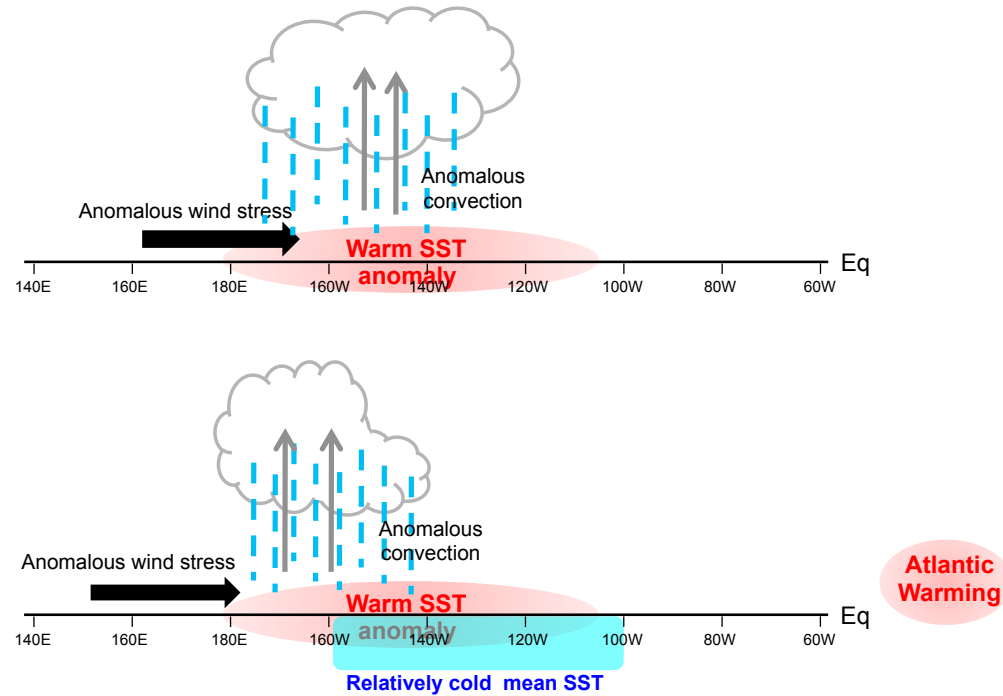
➤ Time series of NINO 3 index



$\sigma(NINO\ 3\ Index)$ CNT_Taux : 1.65 , AMO_Taux : 1.34

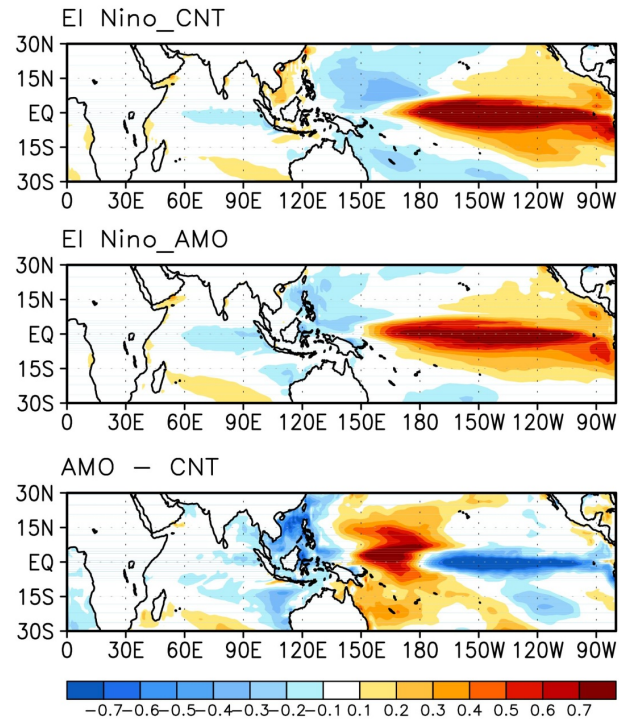
ENSO amplitude shows **20% decrease** when zonal wind stress associated with AMO shifted to the west (AMO_Taux)

Schematic diagram during El Nino



El-Nino SST Anomalies - CGCM

- composite SST (°C) anomalies with DJF Nino 3 index.

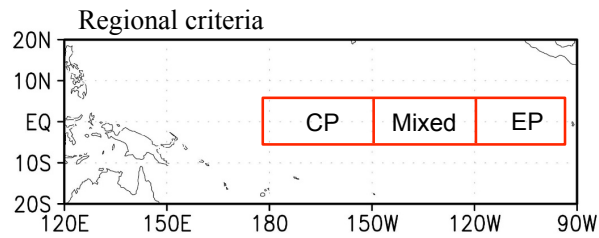
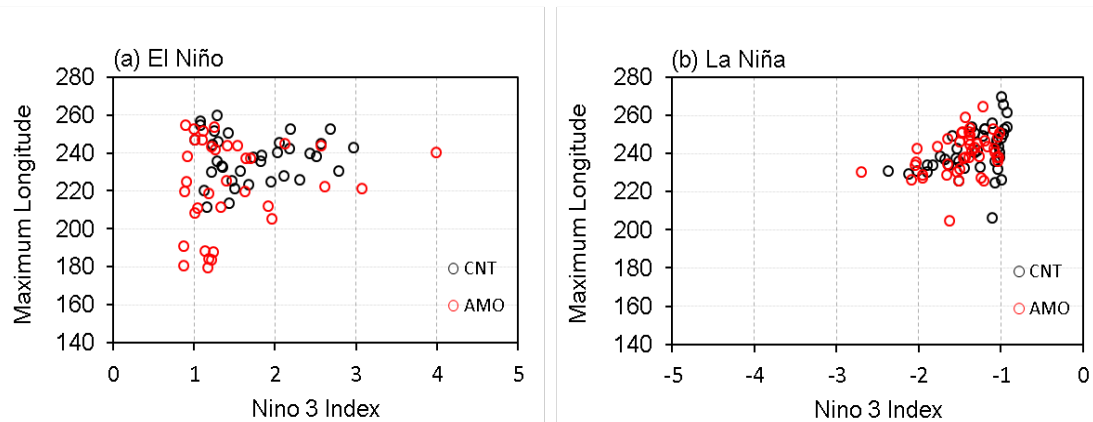


Frequent occurrence of the so-called central Pacific El Niño events in recent decades

(Xiang et al. 2013; Chung and Li 2013)

Location of ENSO SSTA center - CGCM

Scatterplot of (a) warming center of SST, and (b) cooling center of SST anomalies against Nino 3 index in winter (D(0)JF(1))



Experiment	CP El Niño	Mixed El Niño	EP El Niño
CNT	-	20 times (57%)	15 times (43%)
AMO	10 times (29%)	12 times (34%)	13 times (37%)

Summary

- ✓ **Impact of AMO on the mean SST in the tropical Pacific**
 - ⇒ SST Cooling in the central and eastern Pacific.
 - ⇒ Warm pool plays an important role for the Pacific mean changes

- ✓ **Impact of +AMO on ENSO variability.**
 - ⇒ Weaker ENSO.
 - ⇒ Westward shift of ENSO circulation anomalies associated with the central Pacific cooling

Thank you

- Kang, I.-S., H. No, and F. Kucharski, **2014**: ENSO amplitude modulation associated with the mean SST changes in the tropical central Pacific induced by Atlantic Multi-decadal Oscillation. *J. Climate*
- Hong, S., I.-S. Kang, I. Choi, and Y. G. Ham, **2013**: Climate responses in the tropical Pacific associated with Atlantic warming in recent decades. *Asia-Pac J Atmos Sci*, 49, 209-217.